an axis of torsion X–X' and having different stiffness values suitably selected during manufacture as a function of the intended use of the shoe.

For example, in shoes designed especially for high mountain walking (FIG. 6), the rib 9A may be constituted by a rigid rear zone 9*a*, an intermediate semi-rigid zone 9*b* capable of promoting flection in the area of the metatarsals in the foot 4, and a rigid front zone 9*c* in the phalangeal area.

For shoes especially designed for walking in medium mountain altitudes (FIG. 6), the rib 9A may be constituted by a rigid rear zone 9*a*, a flexible intermediate zone 9*b* more broadly promoting flection in the area of the metatarsals in the foot 4 and extension of the foot, and a rigid front zone 9*c* in the phalangeal area.

The rib layer 9 may also be made of a composite material having different rigidity/flectional characteristics along different axes and exhibiting both, a high degree of stiffness under torsion (in a direction perpendicular to the axis X–X') and a degree of flexibility under torsion along axis X–X'.

In the embodiment shown in FIGS. 7 and 8 (in which the comfort layer 8 is omitted), the intermediate rigid layer or rib 9B is constituted, at least in the metatarsal area, by a succession of rigid inserts 10 arranged in alternating fashion perpendicularly to the axis of torsion X–X' of the sole, so as to obtain good flexibility under flection while preserving an effective level of stiffness under torsion. These inserts 10 can be produced in the same molding operation as that used for the rest of the rib layer 9B.

The inserts 10 forming the rib 9B are preferably made during a single molding operation used to mold this layer 9B with the contact layer 7.

In the embodiment illustrated in FIGS. 9 and 10, the intermediate layer, or rib, 9C comprises, near its front and rear portions, two arcuate recesses 11*a*, 11*b* substantially corresponding to the ends of the sole and capable of allowing the passage of two stops 12, 13 projecting from the contact layer 7 and having inner surfaces to which portions of the upper 3 are adhesively bonded.

This latter solution offers the advantage that a shoulder 14, 15 perpendicular to the outer surfaces of the stops 12, 13 remains between the latter and the upper plane of the rib 9C, so as to obtain an attachment surface designed for the installation of ice studs in a high mountain boot. In the variant illustrated in FIG. 11, the stops 12, 13 are also formed from the contact layer 7, but it is these stops which have recesses 12*a*, 13*a*, respectively, to allow passage of the rib layer 9*c*, which thus comprises no recess.

The variant shown in FIG. 12 a sole 2A in which the rear portion of the comfort layer BA comprises a balanced heel-portion 6A unitary with layer 8A, and which replaces the external heel 6 in the boot 1. Accordingly, the contact layer 7 has a substantially uniform thickness over its entire length.

According to another variant, shown in FIGS. 15 and 16, the comfort layer is constituted by raised projections 8B made from the material on the upper portion 7*a* of the contact layer 7, whose shape corresponds to recesses 16 in the intermediate layer, or rib 9D, which they traverse and clear by an amount equal to the thickness of the comfort layer to be produced. The layer 9D can also be simply duplicate-molded on the contact layer 7 which incorporates these projections.

In the example shown, the projections 8B are constituted by points uniformly spaced in the area of the metatarsals and the heel. Of course, they could cover the entire surface of the foot.

The advantage of this solution is that it can produce a triple-layer sole according to the invention using two materials only, the flexibility of the comfort layer 8A to be obtained being a function of the density and/or the geometry of the points which constitute it.

FIG. 13 illustrates a contact layer 7A constituted by a plurality of zones, including a first peripheral zone 17 corresponding to a principal mechanical ground-gripping zone, a second central front zone 18 corresponding to a secondary gripping or position-maintenance zone, and a third central rear neutral zone 19.

During walking, the first contact with the ground occurs principally on the periphery 17 of the sole. This periphery is thus carefully designed for maximum wear resistance and in order not to pick up dirt, so as to preserve its gripping properties.

According to a variant illustrated in FIG. 14, the contact layer 7B is formed by skids mounted externally on the rib 9 in recesses 20 provided for that purpose in the latter, and whose depth is less than that of the skids themselves.

Skids 7B are preferably arranged on either side of the longitudinal torsion axis, in this particular instance on either side of a central groove in a cross-country ski boot.

In an application of the invention to cross-country ski or Nordic hiking boots (FIG. 17), the rigid intermediate layer 9E is used for the mechanical attachments of an attachment loop 21 designed to cooperate with a hinge-type binding optionally comprising an internal metal reinforcement insert, this insert and/or this loop 21 being duplicate molded in rigid intermediate layer 9E, such as that described in French Patent No. 91 04126 filed by Applicant. Of course, the rigid layer can be used for any other type of mechanical attachment of an interface.

For example, the rigid intermediate layer or rib 9 may be used for mechanical attachment of a metal insert cooperating with the binding of a pedal in a cycling application, the insert being duplicate molded in intermediate layer 9.

In an application of the invention to golf shoes (FIG. 18), the lower part of rigid intermediate layer is provided with threaded holes 22 or rib 9F for the mechanical attachment of studs (not shown) in a screwed-in configuration.

The hardnesses of the different layers forming the sole are preferably as follows:

- the intermediate layer or rib 9, 9A, 9B, 9C, 9D, 9E, 9F has a hardness of more than 45 Shore D;
- the ground-contact layer 7, 7A, 7B has a hardness of less than 45 Shore D;
- the comfort layer 8, 8A, 8B has a hardness of less than 80 shore A.

In addition, according to a preferred embodiment of the invention, the ground-contact layer 7, 7A, 7B is made of rubber with gripping and abrasion-resistance properties.

However, this does not exclude a ground-contact layer 7, 7A, 7B also made of a polyurethane or any other thermoplastic material.

The rigid intermediate layer or rib 9, 9A, 9B, 9C, 9D, 9E, 9F may be made of filled or unfilled polyurethane (glass or carbon fibers, etc.), filled or unfilled polyamide, by a filled or unfilled polyethylene, or any other thermoplastic material.

It should also be noted that each of the layers 7, 8, 9 of the sole 2 may or may not extend over the entire surface of the sole (see, for example, the FIGS. 14 and 15 embodiment).

Finally, the layers 7, 8, 9 constituting the sole 2 may be connected by any means, such as adhesive bonding, duplicate molding, or ultrasound.

What is claimed is:

1. In a sport shoe comprising an upper, a sole made from a laminated profile comprising several layers performing distinct functions, respectively, said sole being surmounted

by said upper, wherein said sole comprises at least three layers external to said upper, namely:

(a) a ground contact layer with determinate properties of flexibility, gripping and abrasion-resistance which provide good foot extension, good ground traction and a high level of wear resistance;

(b) an upper comfort layer located directly beneath the foot, said upper comfort layer having elastic shock-absorption properties and being assembled on said upper of said shoe; and

(c) an intermediate layer of said sole, arranged directly between an upper part of said ground contact layer, by one of its faces, and the lower part of said comfort layer by its other face, having controlled torsional and flectional rigidity, and providing both for the distribution of shockwaves and stresses sensed by said ground contact layer and for their diffusion over said comfort layer before coming in contact with the foot, said intermediate layer extending over an entire surface of said ground contact layer and constituting a framework for the ground contact layer preventing deformation of the ground contact layer and thereby permitting it to be made of softer, more adherent rubber.

2. Sole according to claim **1**, wherein said ground contact layer, said upper comfort layer and said intermediate layer are substantially congruous with one another.

3. Sole according to claim **1**, wherein said comfort layer is composed of several distinct adjoining zones, said zones including a first zone corresponding to the heel and having a first degree of elasticity; a second zone corresponding to the arch and having a degree of elasticity less than said first zone; and a third zone having a degree of elasticity less than said second zone and promoting control of walking.

4. Sole according to claim **1**, wherein said intermediate layer has a substantially constant rigidity at all points, said rigidity being selected during manufacture as a function of intended use of the shoe.

5. Sole according to claim **1**, wherein said intermediate layer has a hardness greater than 45 Shore D.

6. Sole according to claim **1**, wherein said ground contact layer has a ha rd ness of less than 45 Shore D.

7. Sole according to claim **1**, wherein said comfort layer has a hardness of less than 80 Shore A.

8. Sole according to claim **1**, herein said ground contact layer is made of rubber having traction and abrasion-resistance properties.

9. Sole according to claim **1**, wherein said ground contact sole is made of a thermoplastic material.

10. Sole according to claim **3**, wherein said intermediate layer is made of a material selected from the group consisting of filled and unfilled thermoplastic material.

11. Sole according to claim **1**, wherein said layers constituting said sole are connected by adhesive bonding.

12. Sole according to claim **1**, wherein said layers constituting said sole are connected by duplicate molding.

13. Sole according to claim **1**, wherein said layers constituting said sole are connected by ultrasound.

14. Sole according to claim **1**, wherein said intermediate layer, or rib (**9A**) is constituted by a plurality of zones (*9a*, *9b*, *9c*) extending on either side of an axis of torsion (X–x') whose stiffness values are different and suitably selected during manufacture as a function of the intended use of the shoe.

15. Sole according to claim **14**, wherein, for shoes especially designed for high mountain walking, said rib (**9A**) is constituted by a rigid rear zone (*9a*), a semi-rigid intermediate zone (*9b*) promoting flection in the metatarsal area of the foot (**4**), and a rigid front zone (*9c*) in the phalangeal area.

16. Sole according to claim **14**, wherein, for shoes especially designed for walking in medium mountain altitudes, said rib (**9A**) is constituted by a rigid rear zone (*9a*), a flexible intermediate zone (*9b*) promoting flection in the area of the metatarsals in the foot (**4**), and a rigid front zone (*9c*) in the phalangeal area.

17. Sole according to claim **1**, wherein said rigid intermediate layer, or rib (**9B**) is constituted, at least in the metatarsal area, by a succession of rigid inserts (**10**) arranged in alternating fashion perpendicularly to the axis of torsion (X–X') of said sole, so as to obtain good flexibility under flection while preserving good stiffness under torsion.

18. Sole according to claim **17**, wherein said inserts (**10**) constituting said rib (**9B**) and said rib layer **9B** are produced during a single molding operation.

19. Sole according to claim **1**, wherein said intermediate layer, or rib (**9C**) comprises, in proximity to its front and rear portions, two arc-shaped recesses (*11a*, *11b*) substantially corresponding to the ends of said sole and capable of allowing passage of two stops (**12**, **13**) formed from said contact layer (**7**) and on the inner surfaces of which parts of the upper (**3**) are adhesively bonded.

20. Sole according to claim **19**, wherein a shoulder (**14**, **15**) perpendicular to the outer surfaces of said stops (**12**, **13**) remains between the latter and the plane of said rib (**9C**) so as to produce an attachment designed for installation of ice studs, in a high mountain boot.

21. Sole according to claim **1**, wherein said comfort layer (**8A**) comprises, in its rear part, a balanced heel-piece (**6A**) produced as a single piece with said layer (**8A**) and replacing the outer heel-piece (**6**) of said shoe (**1**).

22. Sole according to claim **1**, wherein said ground-contact layer (**7A**) is constituted by a plurality of zones, including a first peripheral zone (**17**) corresponding to a principal mechanical ground-gripping zone, a second central front zone (**18**) corresponding to a secondary position-maintenance or gripping zone, and a third neutral central rear zone (**19**).

23. Sole according to claim **1**, wherein said ground-contact layer (**7B**) is formed from skids mounted externally on said rib (**9**) in recesses (**20**) provided in the latter for that purpose.

24. Sole according to claim **1**, wherein said comfort zone is constituted by points (*8b*) made of the material on the upper part (*7a*) of said contact layer (**7**), and which pass through said intermediate layer, or rib (**9D**) and clear it by a value equal to the thickness of said comfort layer to be produced.

25. Sole according to claim **1**, wherein said rigid intermediate layer, or rib, (**9E**) allows mechanical attachment of a hinge-type binding loop (**21**) in an application to cross-country ski or Nordic hiking boots, comprising or not an inner metal strengthening insert, said insert and/or said loop (**21**) being duplicate molded in said rigid intermediate layer (**9E**).

26. Sole according to claim **1**, wherein said rigid intermediate layer, or rib (**9**) can allow mechanical attachment of an insert cooperating with an associated binding for assembly of said sole to an element such as a ski, cycle pedal, etc., said insert being duplicate molded in said rigid intermediate layer **9**).

27. Sole according to claim **21**, wherein said intermediate layer, or rib (**9F**) can allow mechanical attachments of studs in a screw-in configuration in an application to golf shoes.

* * * * *

28. In a sport shoe comprising an upper, a sole made from a laminated profile comprising several layers performing distinct functions, respectively, said sole being surmounted by said upper, wherein said sole comprises at least three layers external to said upper,
namely:
(a) a ground contact layer with determinate properties of flexibility, gripping and abrasion-resistance which provide good foot extension, good ground traction and a high level of wear resistance;
(b) an upper comfort layer located directly beneath the foot, said upper comfort layer having elastic shock-absorption properties and being assembled on said upper of said shoe; and
(c) an intermediate layer of said sole, arranged directly between an upper part of said ground contact layer, by one of its faces, and the lower part of said comfort layer by its other face, having controlled torsional and flectional rigidity, and providing both for the distribution of shockwaves and stresses sensed by said ground contact layer and for their diffusion over said comfort layer before coming in contact with the foot, said intermediate layer extending over substantially an entire surface of said ground contact layer which is located directly beneath a foot of a person wearing the sport shoe, and constituting a framework for the ground contact layer preventing deformation of the ground contact layer and thereby permitting it to be made of softer, more adherent rubber.

29. In a sport shoe comprising an upper, a sole made from a laminated profile comprising several layers performing distinct functions, respectively, said sole being surmounted by said upper, wherein said sole comprises at least three layers external to said upper, namely:
(a) a ground contact layer with determinate properties of flexibility, gripping and abrasion-resistance which provide good foot extension, good ground traction and a high level of wear resistance;
(b) an upper comfort layer located directly beneath the foot, said upper comfort layer having elastic shock-absorption properties and being assembled on said upper of said shoe; and
(c) an intermediate layer of said sole, arranged directly between an upper part of said ground contact layer, by one of its faces, and the lower part of said comfort layer by its other face, having controlled torsional and flectional rigidity, and providing both for the distribution of shockwaves and stresses sensed by said ground contact layer and for their diffusion over said comfort layer before coming in contact with the foot, said intermediate layer extending over at least a surface of said ground contact layer which is directly beneath a lateral portion of a heel of a person wearing the sport shoe, and constituting a framework for the ground contact layer preventing deformation of the ground contact layer and thereby permitting it to be made of softer, more adherent rubber.